CLAIMS

What is claimed is:

1. A method for aligning a plurality of optical elements in an optical device, comprising the steps of:

(a) placing at least a first optical element in a first beam path;

(b) fixing the first optical element in place without substantially compensating for errors in optical alignment;

(c) placing at least a first optical alignment element (OAE) in the first beam path; and

(d) aligning the first beam path to a first desired beam path by adjusting the first OAE, wherein the alignment of the first beam path substantially compensates for cumulative alignment errors in the first beam path.

2. The method of claim 1, wherein the first OAE comprises two coupled, non-parallel, and non-co-planar surfaces, wherein at least one of the surfaces comprises a refractive or defractive element.

3. The method of claim 1, wherein the first OAE comprises two coupled, non-parallel, and non-co-planar surfaces, wherein each of the two of the coupled, non-parallel, and non-co-planar surfaces include a reflective element in the first beam path.

4. The method of claim 1, wherein the first optical element comprises one of the

following:

a lens;

a mirror;

a collimator;

a laser;

a detector;

an optical fiber;

a fiber collimator;

a light emitting diode;

a holographic element;

an optical signal modulator;

a thermoelectrically cooled laser

a grating; and

an array of optical devices.

5. The method of claim 1, wherein the first optical element is a first filter.

6. The method of claim 4, wherein the first filter is a first reflective notch filter.

7. The method of claim 1, further comprising:

(a1) placing at least a second optical element in a second beam path;

(b1) fixing the second optical element in place without substantially compensating for

errors in optical alignment;

(c1) placing at least a second OAE in the second beam path; and

(d1) aligning the second beam path to a second desired beam path by adjusting the second OAE, wherein the alignment of the second beam path substantially compensates for cumulative alignment errors in the second beam path.

8. The method of claim 7, wherein the second optical element comprises a second filter.

9. The method of claim 8, wherein the second filter is a second reflective notch filter.

10. The method of claim 7, further comprising:

(a2) placing at least a third optical element in a third beam path;

(b2) fixing the third optical element in place without substantially compensating for errors in optical alignment;

(c2) placing at least a third OAE in the third beam path; and

(d2) aligning the third beam path to a third desired beam path by adjusting the third OAE, wherein the alignment of the third beam path substantially compensates for cumulative alignment errors in the third beam path.

11. The method of claim 9, wherein the third optical element comprises a third filter.

12. The method of claim 11, wherein the third filter is a third reflective notch filter.

13. The method of claim 10, further comprising:

(a3) placing at least a fourth optical element in a fourth beam path;

(b3) fixing the fourth optical element in place without substantially compensating for errors in optical alignment;

(c3) placing at least a fourth OAE in the fourth beam path; and

(d3) aligning the fourth beam path to a fourth desired beam path by adjusting the fourth OAE, wherein the alignment of the fourth beam path substantially compensates for cumulative alignment errors in the fourth beam path.

14. The method of claim 13, wherein the fourth optical element comprises a fourth filter.

15. The method of claim 14, wherein the fourth filter is a fourth reflective notch filter.

16. The method of claim 1, wherein the adjusting step (d) comprises:

(d1) selecting values for a plurality of parameters;

(d2) adjusting a placement and an orientation of the first OAE in the first beam path along a plurality of axes;

(d3) determining a power level for the first beam path at a location; and

(d4) repeating steps (d2) and (d3) if the power level for the first beam path is not

approximately a desired power level.

17. The method of claim 16, further comprising:

(d2i) adjusting a placement and an orientation of a second OAE in a second beam path along the plurality of axes;

(d3i) determining a power level for the second beam path at the location; and

(d4i) repeating steps (d2i) and (d3i) if the power level for the second beam path is not approximately a desired power level.

18. The method of claim 17, further comprising:

(d2ii) adjusting a placement and an orientation of a third OAE in a third beam path along the plurality of axes;

(d3ii) determining a power level for the third beam path at the location; and

(d4ii) repeating steps (d2ii) and (d3ii) if the power level for the third beam path is not approximately a desired power level.

19. The method of claim 18, further comprising:

(d2iii) adjusting a placement and an orientation of a fourth OAE in a fourth beam path along the plurality of axes;

(d3iii) determining a power level for the fourth beam path at the location; and

(d4iii) repeating steps (d2iii) and (d3iii) if the power level for the fourth beam path is not approximately a desired power level.

20. The method of claim 1, further comprising:

(e) fixing the first OAE in the first beam path in place.

21. The method of claim 20, wherein the fixing step (e) includes the use of epoxy.

22. The method of claim 20, wherein the fixing step (e) includes the use of welding.

23. The method of claim 20,wherein the fixing step (e) includes the use of soldering.

24. The method of claim 20, further comprising:

(e1) fixing a second OAE in a second beam path in place.

25. The method of claim 24, further comprising:

(e2) fixing a third OAE in a third beam path in place.

26. The method of claim 25, further comprising:

(e3) fixing a fourth OAE in a fourth beam path in place.

27. The method of claim 1, comprising:

placing a fifth optical element in the first beam path;

fixing the fifth optical element in place without substantially compensating for errors in optical alignment;

placing a sixth optical element in the first beam path; and

fixing the sixth optical element in place without substantially compensating for errors in optical alignment.

28. The method of claim 1, wherein:

the optical device includes a system conforming to an IEEE standard.

29. The method of claim 1, wherein:

the optical device includes a system conforming to an IEEE 802 standard.

30. The method of claim 1, wherein:

the optical device includes a system conforming to one or more of a XAUI, XENPAK and XGP transceiver standard.

31. A method for aligning a plurality of optical elements in an optical device, comprising the steps of:

(a) placing at least a first optical element in a first beam path and at least a second optical element in a second beam path;

(b) fixing the first optical element and the second optical element in place without substantially compensating for errors in optical alignment;

(c) placing at least a first OAE in the first beam path and at least a second OAE in the second beam path; and

(d) aligning the first beam path to a first desired beam path by adjusting the first OAE and aligning the second beam path to a second desire beam path by adjusting the second OAE, wherein the alignment of the first beam path substantially compensates for cumulative alignment errors in the first beam path, wherein the alignment of the second beam path substantially compensates for cumulative alignment errors in the second beam path.

32. The method of claim 31, wherein the first OAE comprises two coupled, non-parallel, and non-co-planar surfaces, wherein at least one of the surfaces comprises a refractive or defractive element.

33. The method of claim 31, wherein the first OAE comprises two coupled, non-parallel, and non-co-planar surfaces, wherein each of the two of the coupled, non-parallel, and non-co-planar surfaces include a reflective element in the first beam path.

34. The method of claim 31, wherein the second OAE comprises two coupled, non-parallel, and non-co-planar surfaces, wherein at least one of the surfaces comprises a refractive or defractive element.

35. The method of claim 31, wherein the first OAE comprises two coupled, non-parallel, and non-co-planar surfaces, wherein each of the two of the coupled, non-parallel, and non-co-planar surfaces include a reflective element in the first beam path.

36. The method of claim 31, wherein the first optical element comprises one of the following:

a lens;

a mirror;

a collimator;

a laser;

a detector;

an optical fiber;

a fiber collimator;

a light emitting diode;

a holographic element;

an optical signal modulator;

a thermoelectrically cooled laser

a grating; and

an array of optical devices.

37. The method of claim 31, wherein the second optical element comprises one of the following:

a lens;

a mirror;

a collimator;

a laser;

a detector;

an optical fiber;

a fiber collimator;

a light emitting diode;

a holographic element;

an optical signal modulator;

a thermoelectrically cooled laser

a grating; and

an array of optical devices.

38. The method of claim 31, wherein the first optical element is a first filter and the second optical element is a second filter.

39. The method of claim 38, wherein the first filter is a first reflective notch filter and the second filter a second reflective notch filter.

40. The method of claim 31, further comprising:

(a1) placing at least a third optical element in a third beam path;

(b1) fixing the third optical element in place without substantially compensating for errors in optical alignment;

(c1) placing at least a third OAE in the third beam path; and

(d1) aligning the third beam path to a third desired beam path by adjusting the third

OAE, wherein the alignment of the third beam path substantially compensates for cumulative alignment errors in the third beam path.

41. The method of claim 40, wherein the third optical element comprises a third filter.

42. The method of claim 41, wherein the third filter is a third reflective notch filter.

43. The method of claim 40, further comprising:

(a2) placing at least a fourth optical element in a fourth beam path;

(b2) fixing the fourth optical element in place without substantially compensating for errors in optical alignment;

(c2) placing at least a fourth OAE in the fourth beam path; and

(d2) aligning the fourth beam path to a fourth desired beam path by adjusting the fourth OAE, wherein the alignment of the fourth beam path substantially compensates for cumulative alignment errors in the fourth beam path.

44. The method of claim 43, wherein the fourth optical element comprises a fourth filter.

45. The method of claim 44, wherein the fourth filter is a fourth reflective notch filter.

46. The method of claim 31, wherein the adjusting step (d) comprises:

(d1) selecting values for a plurality of parameters;

(d2) adjusting a placement and an orientation of the first OAE in the first beam path along a plurality of axes;

(d3) determining a power level for the first beam path at a location;

(d4) repeating steps (d2) and (d3) if the power level for the first beam path is not approximately a desired power level;

(d5) adjusting a placement and an orientation of a second OAE in a second beam path along the plurality of axes;

(d6) determining a power level for the second beam path at the location; and

(d7) repeating steps (d5) and (d6) if the power level for the second beam path is not approximately a desired power level.

47. The method of claim 39, further comprising:

(d2i) adjusting a placement and an orientation of a third OAE in a third beam path along the plurality of axes;

(d3i) determining a power level for the third beam path at the location; and

(d4i) repeating steps (d2i) and (d3i) if the power level for the third beam path is not approximately a desired power level.

48. The method of claim 47, further comprising:

(d2ii) adjusting a placement and an orientation of a fourth OAE in a fourth beam path along the plurality of axes;

(d3ii) determining a power level for the fourth beam path at the location; and

(d4ii) repeating steps (d2ii) and (d3ii) if the power level for the fourth beam path is not approximately a desired power level.

49. The method of claim 31, further comprising:

(e) fixing the first OAE in the first beam path in place; and

(f) fixing the second OAE in the second beam path in place.

50. The method of claim 49, wherein at least one of the fixing steps (e) and (f) includes epoxy.

51. The method of claim 49, wherein at least one of the fixing steps (e) and (f) includes welding.

52. The method of claim 49,wherein at least one of the fixing steps (e) and (f) includes soldering.

53. The method of claim 49, further comprising:

(e1) fixing a third OAE in a third beam path in place.

54. The method of claim 53, further comprising:

(e2) fixing a fourth OAE in a fourth beam path in place.

55. The method of claim 31, comprising:

placing a fifth optical element in the first beam path;

fixing the fifth optical element in place without substantially compensating for errors in at least one axis of optical alignment;

placing a sixth optical element in the first beam path; and

fixing the sixth optical element in place without substantially compensating for errors in at least one axis of optical alignment.

56. The method of claim 31, wherein:

the optical device includes a system conforming to an IEEE standard.

57. The method of claim 31, wherein:

the optical device includes a system conforming to an IEEE 802 standard.

58. The method of claim 31, wherein:

the optical device includes a system conforming to one or more of a XAUI, XENPAK and XGP transceiver standard.

59. A method for aligning a plurality of optical elements in an optical device, comprising the steps of:

(a) placing a plurality of optical elements in a plurality of beam paths;

(b) fixing the plurality of optical elements in place without substantially compensating for errors in alignment to a location;

(c) placing a plurality of OAE in the plurality of beam paths; and

(d) attempting to actively align the plurality of OAE to the location, wherein alignments of the plurality of OAE would substantially compensate for cumulative alignment errors in the plurality of beam paths.

60. The method of claim 59, wherein at least one of the plurality of OAE comprises two coupled, non-parallel, and non-co-planar surfaces, wherein one or more of the surfaces comprises a refractive or defractive element.

61. The method of claim 59, wherein at least one of the plurality of OAE comprises two coupled, non-parallel, and non-co-planar surfaces, wherein each of the two of the coupled, non-parallel, and non-co-planar surfaces include a reflective element.

62. The method of claim 59, wherein at least one of the plurality of optical elements comprises one of the following:

a lens;

a mirror;

a collimator;

a laser;

a detector;

an optical fiber;

a fiber collimator;

a light emitting diode;

a holographic element;

an optical signal modulator;

a thermoelectrically cooled laser

a grating; and

an array of optical devices.

63. The method of claim 59, wherein the placing step (a) comprises:

(a1) placing at least a first optical element in the first beam path and at least a second optical element in the second beam path;

(b1) fixing the first optical element and the second optical element in place without substantially compensating for errors in optical alignment;

(c1) placing at least a first OAE in the first beam path and at least a second OAE in the second beam path; and

(d1) aligning the first beam path to a first desired beam path by adjusting the first OAE and aligning the second beam path to a second desired beam path by adjusting the second OAE, wherein the alignment of the first beam path substantially compensates for alignment errors in the first beam path, wherein the alignment of the second beam path substantially compensates for alignment errors in the second beam path.

64. The method of claim 63, wherein the first optical element is a first filter and the second optical element is a second filter.

65. The method of claim 64, wherein the first filter is a first reflective notch filter and the second filter a second reflective notch filter.

66. The method of claim 63, further comprising:

(a2) placing at least a third optical element in a third beam path;

(b2) fixing the third optical element in place without substantially compensating for errors in optical alignment;

(c2) placing at least a third OAE in the third beam path; and

(d2) aligning the third beam path to a third desired beam path by adjusting the third OAE, wherein the alignment of the third beam path substantially compensates for cumulative alignment errors in the third beam path.

67. The method of claim 66, wherein the third optical element comprises a third filter.

68. The method of claim 67, wherein the third filter is a third reflective notch filter.

69. The method of claim 66, further comprising:

(a3) placing at least a fourth optical element in a fourth beam path;

(b3) fixing the fourth optical element in place without substantially compensating for errors in optical alignment;

(c3) placing at least a fourth OAE in the fourth beam path; and

(d3) aligning the fourth beam path to a fourth desired beam path by adjusting the

fourth OAE, wherein the alignment of the fourth beam path substantially compensates for cumulative alignment errors in the fourth beam path.

70. The method of claim 69, wherein the fourth optical element comprises a fourth filter.

71. The method of claim 70, wherein the fourth filter is a fourth reflective notch filter.

72. The method of claim 59, wherein the adjusting step (d) comprises:

(d1) selecting values for a plurality of parameters;

(d2) adjusting a placement and an orientation of a first OAE in a first beam path along a plurality of axes;

(d3) determining a power level for the first beam path at a location;

(d4) repeating steps (d2) and (d3) if the power level for the first beam path is not approximately a desired power level;

(d5) adjusting a placement and an orientation of a second OAE in a second beam path along the plurality of axes;

(d6) determining a power level for the second beam path at the location; and

(d7) repeating steps (d5) and (d6) if the power level for the second beam path is not approximately a desired power level.

73. The method of claim 72, further comprising:

(d2i) adjusting a placement and an orientation of a third OAE in a third beam path along the plurality of axes;

(d3i) determining a power level for the third beam path at the location; and

(d4i) repeating steps (d2i) and (d3i) if the power level for the third beam path is not approximately a desired power level.

74. The method of claim 73, further comprising:

(d2ii) adjusting a placement and an orientation of a fourth OAE in a fourth beam path along the plurality of axes;

(d3ii) determining a power level for the fourth beam path at the location; and

(d4ii) repeating steps (d2ii) and (d3ii) if the power level for the fourth beam path is not approximately a desired power level.

75. The method of claim 59, further comprising:

(e) fixing a first OAE in a first beam path in place; and

(f) fixing a second OAE in a second beam path in place.

76. The method of claim 75, wherein at least one of the fixing steps (e) and (f) includes epoxying.

77. The method of claim 75, wherein at least one of the fixing steps (e) and (f) includes welding.

78. The method of claim 75, wherein at least one of the fixing steps (e) and (f) includes soldering.

79. The method of claim 75, further comprising:

(e1) fixing a third OAE in a third beam path in place.

80. The method of claim 79, further comprising:

(e2) fixing a fourth OAE in a fourth beam path in place.

81. The method of claim 59, wherein:

the optical device includes a system conforming to an IEEE standard.

82. The method of claim 59, wherein:

the optical device includes a system conforming to an IEEE 802 standard.

83. The method of claim 59, wherein:

the optical device includes a system conforming to one or more of a XAUI, XENPAK and XGP transceiver standard.

84. A method for aligning a plurality of optical elements in an optical device, comprising the steps of:

(a) placing at least a first optical element in a first beam path;

(b) fixing the first optical element in place without substantially compensating for errors in optical alignment; and

(d) step for aligning the first beam path to a first desired beam path, wherein the alignment of the first beam path substantially compensates for cumulative alignment errors in the first beam path.

85. The method of claim 84, wherein:

the optical device includes a system conforming to an IEEE standard.

86. The method of claim 84, wherein:

the optical device includes a system conforming to an IEEE 802 standard.

87. The method of claim 84, wherein:

the optical device includes a system conforming to one or more of a XAUI, XENPAK and XGP transceiver standard.